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(54) **IMAGE FORMING APPARATUS**

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G03G 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/0011*** (2013.01)

(58) **Field of Classification Search**
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USPC 399/101
See application file for complete search history.

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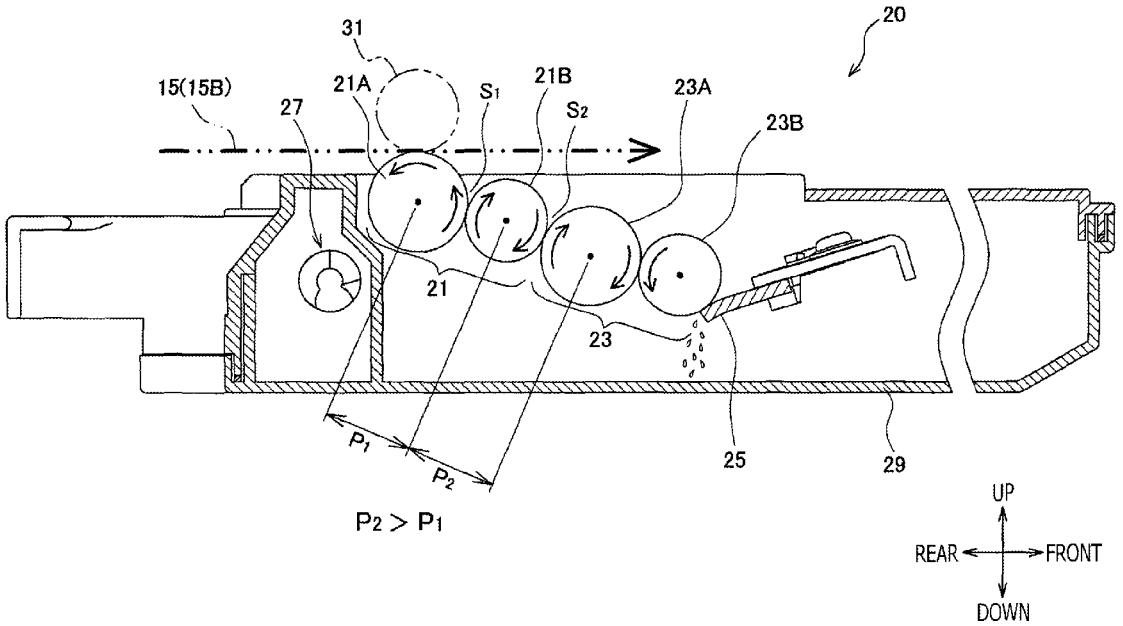
(57) **ABSTRACT**

An image forming apparatus including a belt cleaner including a scraping blade and roller pairs each including an elastic roller and a metal roller, the roller pairs including a first roller pair including a first elastic roller as a cleaning roller contacting a belt while rotating in a rotational tangential direction opposite to a belt traveling direction at a contact portion with the belt, and one or more second roller pairs each including a second elastic roller contacting an adjacent metal roller of a roller pair adjacent to the second roller pair while rotating at a circumferential velocity lower than that of the adjacent metal roller in a rotational tangential direction opposite to that of the adjacent metal roller at a contact portion with the adjacent metal roller, the scraping blade contacting an outer circumferential surface of a specific metal roller of the one or more second roller pairs.

7 Claims, 2 Drawing Sheets



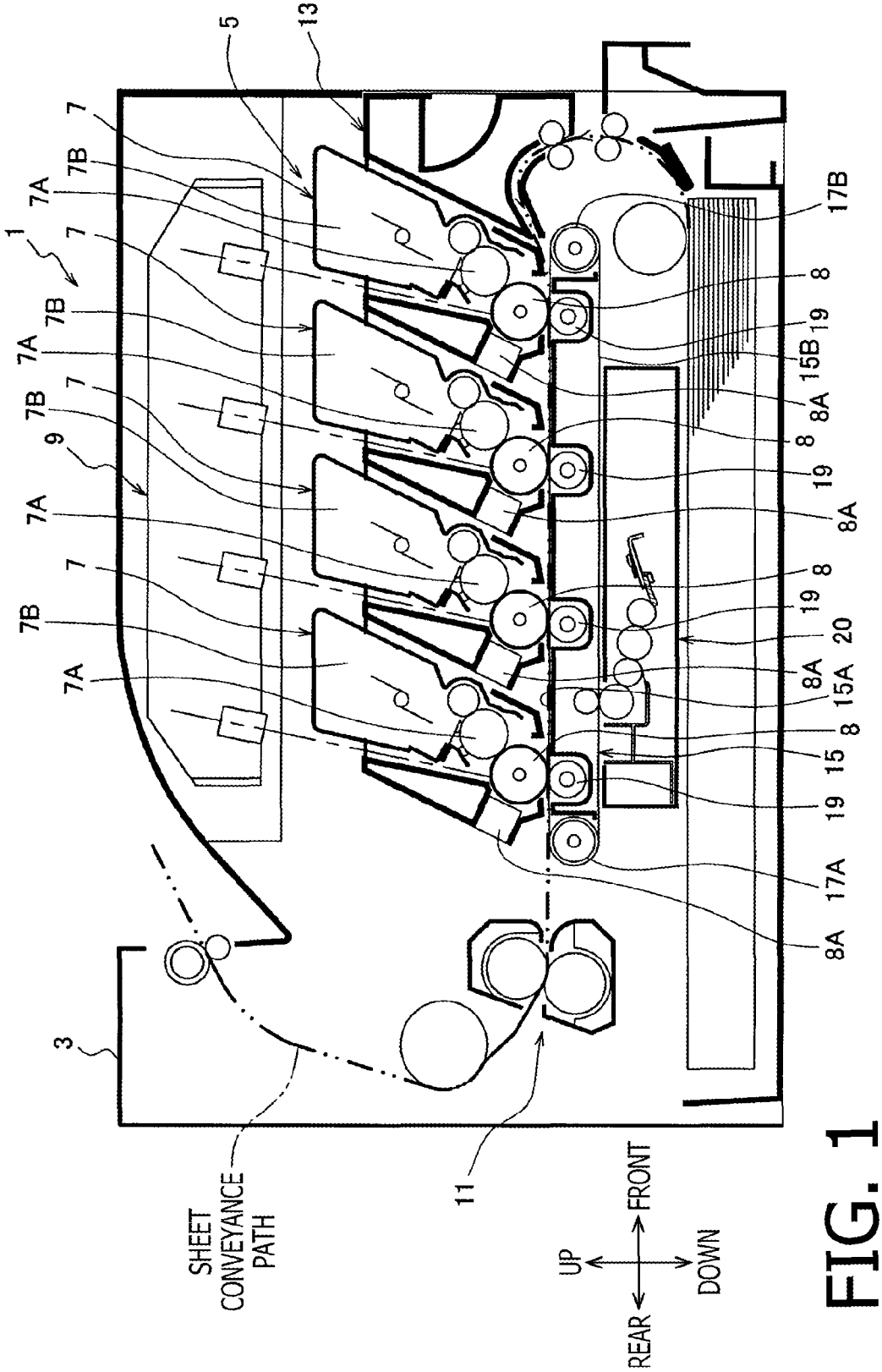
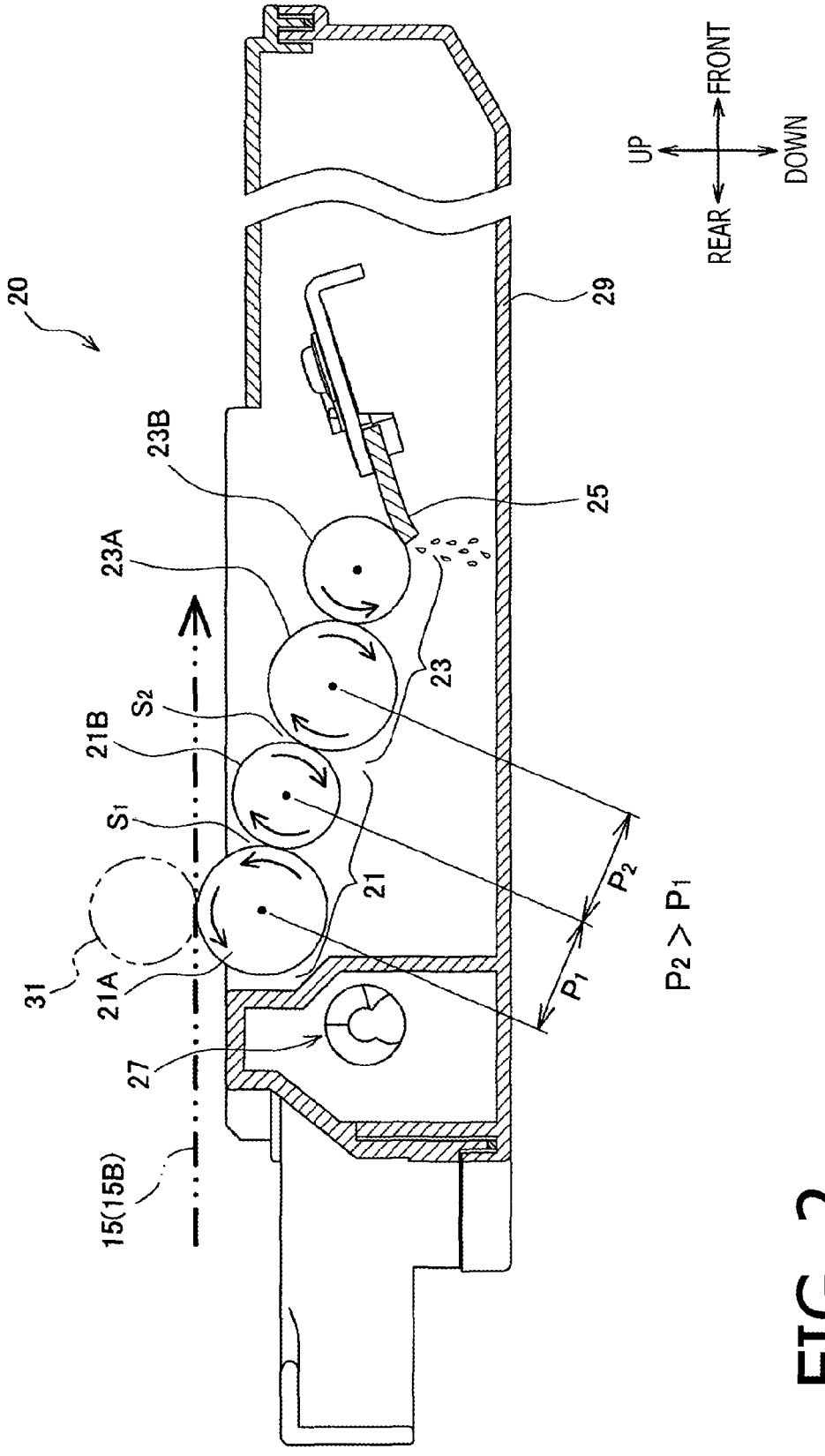

1
3
5
7
7A
7B
8
8A
9
11
13
15
15A
15B
17A
17B
19
20
SHEET CONVEYANCE PATH
UP
DOWN
FRONT
REAR

FIG. 1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29
23B
25
23A
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S_2
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S_1
21
31
21A
27
15(15B)
P_2
P_1
$P_2 > P_1$
UP
FRONT
REAR
DOWN

FIG. 2

IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 from Japanese Patent Application No. 2013-122901 filed on Jun. 11, 2013. The entire subject matter of the application is incorporated herein by reference.

BACKGROUND

1. Technical Field

The following description relates to one or more techniques for an electrophotographic type image forming apparatus having an endless belt.

2. Related Art

An image forming apparatus has been known that includes a belt and is configured to form an image on a sheet in an electrophotographic method. The known image forming apparatus may, for instance, be a direct-printing type image forming apparatus configured to directly transfer a developer image onto a sheet being conveyed on a belt. Alternatively, the known image forming apparatus may be an intermediate-transfer type image forming apparatus configured to transfer a developer image onto a belt, and then transfer onto a sheet the developer image transferred on the belt.

In the electrophotographic type image forming apparatus including the belt, regardless of whether the apparatus is of the direct-printing type or the intermediate-transfer type, it is required to remove from the belt adhesive material such as development agent adhering onto the belt. For instance, a belt cleaner configured to remove adhesive material from the belt may include a cleaning roller, a cleaning shaft, and a scraping blade.

The cleaning roller may be configured to remove adhesive material from the belt while rotating in a rotational tangential direction opposite to a traveling direction of the belt at a contact portion between the cleaning roller and the belt. The cleaning shaft may be configured to remove adhesive material from the cleaning roller while rotating in a rotational tangential direction identical to a rotational tangential direction of the cleaning roller at a contact portion between the cleaning shaft and the cleaning roller. The scraping blade may be configured to scrape off adhesive material from the cleaning shaft while sliding relative to and in contact with an outer circumferential surface of the cleaning shaft.

SUMMARY

In the known image forming apparatus, when a traveling velocity of the belt is raised so as to increase an image forming speed (a printing speed), it is required to raise rotational speeds of the cleaning roller and the cleaning shaft accordingly.

However, a rise in a circumferential velocity of the cleaning shaft in response to the rotational speed of the cleaning shaft being raised might cause a greater vibration (e.g., a greater stick-slip vibration) of the scraping blade. Consequently, it might be impossible to sufficiently scrape off the adhesive material from the cleaning shaft.

Aspects of the present invention are advantageous to provide one or more improved techniques, for an image forming apparatus, which make it possible to suppress a rise in a vibration of a scraping blade even though a traveling velocity of a belt is raised.

According to aspects of the present invention, an image forming apparatus is provided, which includes an endless belt wound around at least two rollers, an electrophotographic image forming unit disposed to face the endless belt, and a belt cleaner configured to remove adhesive material adhering onto the endless belt, the belt cleaner including a scraping blade, and a plurality of roller pairs each including an elastic roller having an outer circumferential surface made of elastic material, and a metal roller having an outer circumferential surface made of metal, the metal roller disposed to contact the outer circumferential surface of the elastic roller, the metal roller configured to remove adhesive material adhering onto the outer circumferential surface of the elastic roller while rotating in a rotational tangential direction identical to a rotational tangential direction of the elastic roller at a contact portion between the metal roller and the elastic roller. The plurality of roller pairs include a first roller pair including a first elastic roller that is a cleaning roller disposed to contact the endless belt and configured to remove the adhesive material adhering onto the endless belt while rotating in a rotational tangential direction opposite to a traveling direction of the endless belt at a contact portion between the cleaning roller and the endless belt, and one or more second roller pairs different from the first roller pair, each second roller pair including a second elastic roller disposed to contact an adjacent metal roller included in a roller pair adjacent to the second roller pair, the second elastic roller configured to remove adhesive material adhering onto an outer circumferential surface of the adjacent metal roller while rotating at a circumferential velocity lower than a circumferential velocity of the adjacent metal roller in a rotational tangential direction opposite to a rotational tangential direction of the adjacent metal roller at a contact portion between the second elastic roller and the adjacent metal roller. The scraping blade is disposed to contact an outer circumferential surface of a specific metal roller included in a specific roller pair of the one or more second roller pairs different from the first roller pair, and configured to scrape adhesive material adhering onto the outer circumferential surface of the specific metal roller.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a cross-sectional side view of an image forming apparatus in a first embodiment according to one or more aspects of the present invention.

FIG. **2** is a cross-sectional side view of a belt cleaner of the image forming apparatus in the first embodiment according to one or more aspects of the present invention.

DETAILED DESCRIPTION

It is noted that various connections are set forth between elements in the following description. It is noted that these connections in general and, unless specified otherwise, may be direct or indirect and that this specification is not intended to be limiting in this respect.

Hereinafter, embodiments, in which aspects of the present invention are applied to an electrophotographic type image forming apparatus, will be described with reference to the accompanying drawings. It is noted that, in the drawings, arrows for indicating directions are shown for the sake of easy understanding of correlations between the drawings and between elements. However, the arrows are not intended to be limiting a scope of the present invention. Further, it is noted that, regarding at least each element set forth with a reference

character, it may be at least one element, unless specified otherwise using expressions such as "a plurality of" and "two or more."

First Embodiment

1. General Configuration of Image Forming Apparatus

As shown in FIG. **1**, an image forming apparatus **1** contains, in a housing **3** thereof, an image forming unit **5** configured to form an image on a sheet. The image forming unit **5** is of an electrophotographic type including a plurality of development cartridges **7**, a plurality of photoconductive drums **8**, an exposure unit **9**, and a fuser unit **11**.

Each development cartridge **7** includes a development roller **7**A and a container **7**B. The plurality of photoconductive drums **8** are disposed in positions corresponding to the plurality of development cartridges **7**, respectively. Each photoconductive drum **8** is configured to carry a developer image thereon. Each of a plurality of chargers **8**A is configured to charge a corresponding photoconductive drum **8** disposed to face the charger **8**A.

The exposure unit **9** is configured to expose the plurality of charged photoconductive drums **8** so as to form an electrostatic latent image on each photoconductive drum **8**. Each development roller **7**A is configured to supply a corresponding photoconductive drum **8** with development agent stored in a corresponding container **7**B so as to form a developer image corresponding to the electrostatic latent image.

The plurality of development cartridges **7** are detachably attached to a single drawer **13**. The drawer **13** is movable relative to an apparatus main body. When the drawer **13** is pulled forward relative to the apparatus main body, the plurality of development cartridges **7** are brought into a state detachable from the drawer **13**.

It is noted that the apparatus main body is an unreplaceable part, including a main frame (not shown) and the housing **3**, which is not allowed to be detached from the apparatus by a user. A belt **15** is an endless belt wound around a driving roller **17**A and a driven roller **17**B. A portion of the belt **15** that faces the image forming unit **5** (hereinafter, the portion may be referred to as a transfer surface **15**A) moves from the driven roller **17**B toward the driving roller **17**A in a state stretched between the driving roller **17**A and the driven roller **17**B.

There are transfer portions **19** each disposed in a position to face a corresponding photoconductive drum **8** across the transfer surface **15**A. Each transfer portion **19** is configured to transfer the developer image carried on a corresponding photoconductive drum **8** onto the transfer surface **15**A or a sheet placed on the transfer surface **15**A.

Accordingly, the developer images carried on the photoconductive drums **8** are transferred onto the transfer surface **15**A or the sheet placed on the transfer surface **15**A in a superimposed manner. It is noted that the image forming unit **5** of the first embodiment is of a direct printing type. Therefore, the developer images are directly transferred onto the sheet placed on the transfer surface **15**A in a superimposed manner. The fuser unit **11** is configured to directly or indirectly heat the development agent transferred on the sheet so as to thermally fix the development agent onto the sheet.

On a side opposite to the image forming unit **5** across the belt **15**, a belt cleaner **20** is disposed. The belt cleaner **20** is configured to remove from the belt **15** adhesive material (such as development agent) adhering onto the belt **15**. It is noted that the belt cleaner **20** of the first embodiment is detachably attached to the apparatus main body in a state where the belt cleaner **20** is disposed below the belt **15**, more specifically, on a side under a lower stretched surface **15**B (hereinafter, which may be referred to as a cleaner-facing surface **15**B) of the belt **15**.

2. Belt Cleaner

2.1 Structure of Belt Cleaner

In the image forming apparatus **1** of the first embodiment, patches for adjusting color densities and/or registration marks for detecting color shifts are transferred onto the belt **15** at such appropriate moments when image formation on a sheet is not performed. Thereafter, the belt cleaner **20** retrieves development agent transferred as the patches and/or the registration marks, as adhesive material adhering onto the belt **15**.

As shown in FIG. **2**, the belt cleaner **20** includes at least two roller pairs **21** and **23**, a scraping blade **25**, an auger **27**, and a storage portion **29**. Hereinafter, the at least two roller pairs **21** and **23** may be referred to as a first roller pair **21** and a second roller pair **23**, respectively, in an order closer to the belt **15**.

The first roller pair **21** includes an elastic roller **21**A and a metal roller **21**B. Likewise, the second roller pair **23** includes an elastic roller **23**A and a metal roller **23**B. Namely, each roller pair **21** and **23** includes a single pair of the elastic roller and the metal roller.

Hereinafter, the elastic roller **21**A of the first roller pair **21** may be referred to as a first elastic roller **21**A. The elastic roller **23**A of the second roller pair **23** may be referred to as a second elastic roller **23**A. Likewise, the metal roller **21**B of the first roller pair **21** may be referred to as a first metal roller **21**B. The metal roller **23**B of the second roller pair **23** may be referred to as a second metal roller **23**B.

The first elastic roller **21**A, of the first roller pair **21** that is a roller pair closest to the belt **15** of the at least two roller pairs **21** and **23**, is configured to contact the cleaner-facing surface **15**B of the belt **15**.

Further, the first elastic roller **21**A is configured to retrieve adhesive material adhering onto the belt **15** while rotating in a rotational tangential direction, opposite to a traveling direction of the belt **15**, at a contact portion in contact with the cleaner-facing surface **15**B. Hereinafter, the first elastic roller **21**A may be referred to as a cleaning roller **21**A.

It is noted that the rotational tangential direction of the cleaning roller **21**A at the contact portion between the cleaning roller **21**A and the cleaner-facing surface **15**B is a direction, which is identical to a rotational direction of the cleaning roller **21**A, of tangential directions of the cleaning roller **21**A at the contact portion between the cleaning roller **21**A and the cleaner-facing surface **15**B.

In the first embodiment, the rotational tangential direction of the cleaning roller **21**A is oriented toward a rear side from a front side of the image forming apparatus **1**. Further, a circumferential velocity of the cleaning roller **21**A is lower than a traveling velocity of the belt **15**.

To the cleaning roller **21**A, applied is an electric potential (in the first embodiment, a negative potential) having a polarity opposite to a polarity of the charged development agent adhering onto the belt **15**. Therefore, the adhesive material adhering onto the belt **15** is removed (retrieved) from the belt **15**, (a) by being mechanically scraped from the belt **15** as the cleaning roller **21**A rotates in the direction opposite to the traveling direction of the belt **15**, and (b) by being attracted by an electrostatic attractive force generated between the cleaning roller **21**A and the adhesive material.

On an opposite side of the cleaning roller **21**A with respect to the cleaner-facing surface **15**B, a backup roller **31** is disposed. The backup roller **31** is configured to press the cleaner-facing surface **15**B against the cleaning roller **21**A. Therefore,

the cleaning roller **21**A is allowed to certainly remove (retrieve) the adhesive material from the belt **15**.

An outer circumferential surface of the cleaning roller **21**A that is configured to contact the belt **15** is made of elastic foamed material such as sponge. Therefore, the adhesive material removed (retrieved) from the belt **15** is held by micropores formed in the outer circumferential surface of the cleaning roller **21**A.

Further, an outer circumferential surface of the second elastic roller **23**A is made of elastic material (e.g., elastic foamed material). It is noted that, in the first embodiment, the outer circumferential surface of the first elastic roller **21**A (i.e., the cleaning roller **21**A) and the outer circumferential surface of the second elastic roller **23**A are made of the same kind of elastic material. Nonetheless, in the belt cleaner **20** according to aspects of the present invention, it is only necessary that at least the outer circumferential surface of the first elastic roller **21**A is made of elastic material (e.g., elastic foamed material).

The first metal roller **21**B is configured to rotate in contact with at least the first elastic roller **21**A of the first roller pair **21** (in which the first metal roller **21**B is included), and to remove (retrieve) adhesive material adhering onto the outer circumferential surface of the first elastic roller **21**A. Further, an outer circumferential surface of the first metal roller **21**B is made of metal.

Further, the first metal roller **21**B is configured to rotate in a rotational tangential direction identical to a rotational tangential direction of the first elastic roller **21**A, at a contact portion between the first metal roller **21**B and the first elastic roller **21**A.

It is noted that the rotational tangential direction of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the first elastic roller **21**A is a direction, which is identical to a rotational direction of the first metal roller **21**B, of tangential directions of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the first elastic roller **21**A.

It is noted that the rotational tangential direction of the first elastic roller **21**A at the contact portion between the first metal roller **21**B and the first elastic roller **21**A is a direction, which is identical to the rotational direction of the first elastic roller **21**A, of tangential directions of the first elastic roller **21**A at the contact portion between the first metal roller **21**B and the first elastic roller **21**A.

In the first embodiment, the rotational tangential direction of the first metal roller **21**B and the rotational tangential direction of the first elastic roller **21**A at the contact portion are such a direction as to become closer to the cleaner-facing surface **15**B. Specifically, those rotational tangential directions are oriented upward from beneath.

The elastic roller **23**A of the plurality of elastic rollers **21**A and **23**A other than the cleaning roller **21**A is configured to contact the metal roller **21**B of the roller pair **21** adjacent to the roller pair **23** in which the elastic roller **23**A is included. Specifically, the second elastic roller **23**A of the second roller pair **23** is configured to contact the first metal roller **21**B of the first roller pair **21**.

The second elastic roller **23**A is configured to rotate in a rotational tangential direction opposite to a rotational tangential direction of the first metal roller **21**B, at a contact portion between the second elastic roller **23**A and the first metal roller **21**B. Further, the second elastic roller **23**A is configured to remove (retrieve) adhesive material adhering onto the outer circumferential surface of the first metal roller **21**B while rotating at a circumferential velocity lower than a circumferential velocity of the first metal roller **21**B.

It is noted that the rotational tangential direction of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the second elastic roller **23**A is a direction, which is identical to the rotational direction of the first metal roller **21**B, of tangential directions of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the second elastic roller **23**A.

It is noted that the rotational tangential direction of the second elastic roller **23**A at the contact portion between the first metal roller **21**B and the second elastic roller **23**A is a direction, which is identical to a rotational direction of the second elastic roller **23**A, of tangential directions of the second elastic roller **23**A at the contact portion between the first metal roller **21**B and the second elastic roller **23**A.

In the first embodiment, the rotational tangential direction of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the second elastic roller **23**A is such a direction as to become farther away from the cleaner-facing surface **15**B, i.e., a direction facing downward from above. Further, the rotational tangential direction of the second elastic roller **23**A at the contact portion between the first metal roller **21**B and the second elastic roller **23**A is a direction facing upward from beneath.

In the same manner as the first elastic roller **21**A, to the first metal roller **21**B, the second elastic roller **23**A, and the second metal roller **23**B, applied is an electric potential having a polarity opposite to a polarity of charged adhesive material adhering onto the rollers **21**B, **23**A, and **23**B. Therefore, the adhesive material adhering onto the rollers **21**B, **23**A, and **23**B is removed (retrieved) by an electrostatic attractive force.

In particular, the second elastic roller **23**A has the rotational tangential direction opposite to the rotational tangential direction of the first metal roller **21**B at the contact portion between the first metal roller **21**B and the second elastic roller **23**A. Hence, the adhesive material adhering onto the first metal roller **21**B is removed (retrieved) by being mechanically scraped as well as the electrostatic attractive force.

The scraping blade **25** is configured to slide relative to and in contact with the outer circumferential surface of the second metal roller **23**B of the second roller pair **23**, farthest from the cleaner-facing surface **15**B, of the plurality of roller pairs **21** and **23**. Thereby, the scraping blade **25** is allowed to mechanically scrape the adhesive material adhering onto the outer circumferential surface of the second metal roller **23**B.

The adhesive material scraped off by the scraping blade **25** is stored into the storage portion **29**. The adhesive material stored in the storage portion **29** is transported to a position spaced apart from the scraping blade **25** by a transporting member (not shown) such as an agitator. Thereby, the retrieved material is accumulating evenly in the storage portion **29**.

The scraping blade **25** is disposed downstream in the traveling direction of the cleaner-facing surface **15**B of the belt **15** relative to a contact position where the cleaning roller **21**A contacts the cleaner-facing surface **15**B. The plurality of elastic rollers **21**A and **23**A and the plurality of metal rollers **21**B and **23**B are arranged along a direction oriented from the contact position toward a downstream side in the traveling direction of the belt **15**.

An arrangement direction in which the plurality of rollers **21**A, **21**B, **23**A, and **23**B are arranged intersects the cleaner-facing surface **15**B of the belt **15**. The scraping blade **25** is disposed to contact the second metal roller **23**B that is located at an end in the arrangement direction of the plurality of **21**A, **21**B, **23**A, and **23**B. It is noted that a beginning in the arrangement direction represents a side closest to the cleaner-facing

surface **15**B, and the end in the arrangement direction represents a side farthest from the cleaner-facing surface **15**B.

The first elastic roller **21**A, the first metal roller **21**B, the second elastic roller **23**A, and the second metal roller **23**B are configured to rotate in a mechanically synchronized manner, via power transmission members (not shown) such as gears and toothed belt. Circumferential velocities of the rollers **21**A, **21**B, **23**A, and **23**B are set in accordance with gear ratios of the power transmission members.

In the first embodiment, a ratio of the circumferential velocity of the first elastic roller **21**A to the traveling velocity of the cleaner-facing surface **15**B is about 0.6. A ratio of the circumferential velocity of the first metal roller **21**B to the traveling velocity of the cleaner-facing surface **15**B is about 0.6. A ratio of the circumferential velocity of the second elastic roller **23**A to the traveling velocity of the cleaner-facing surface **15**B is about 0.36. A ratio of the circumferential velocity of the second metal roller **23**B to the traveling velocity of the cleaner-facing surface **15**B is about 0.36.

The auger **27** is configured to transport the adhesive material stored in the storage portion **29** to a detector (not shown). The detector is configured to detect whether the amount of the adhesive material accumulating in the storage portion **29** (i.e., the belt cleaner **20**) is more than a predetermined amount. It is noted that the "predetermined amount" is a design value appropriately set based on a capacity of the storage portion **29**.

2.2 Contact Surface Pressures of Rollers

At the contact portion (hereinafter referred to as a first contact portion S1) between the first elastic roller **21**A and the first metal roller **21**B, the rotational tangential directions of the two rollers **21**A and **21**B are coincident with each other. At the contact portion (hereinafter referred to as a second contact portion S2) between the first metal roller **21**B and the second elastic roller **23**A, the rotational tangential directions of the two rollers **21**B and **23**A are opposite to each other.

Therefore, a rotational resistance at the second contact portion S2 might be greater than a rotational resistance at the first contact portion S1. When the rotational resistance at the second contact portion S2 is greater than the rotational resistance at the first contact portion S1, there might be caused troubles and/or failures in the rotations of the rollers **21**A, **21**B, **23**A, and **23**B. In the first embodiment, in view of the problem, a contact surface pressure at the second contact portion S2 is set lower than a contact surface pressure at the first contact portion S1.

In other words, in the first embodiment, a contact surface pressure between a specific metal roller **21**B and a downstream elastic roller **23**A is lower than a contact surface pressure between the specific metal roller **21**B and an upstream elastic roller **21**A. It is noted that (a) the specific metal roller **21**B represents the first metal roller **21**B, which is one of the plurality of metal rollers **21**B and **23**B that contacts two elastic rollers **21**A and **23**A. Additionally, (b) the upstream elastic roller **21**A represents the first elastic roller **21**A, which is of the first roller pair **21** including the specific metal roller **21**B. Further, (c) the downstream elastic roller **23**A represents the second elastic roller **23**A, which is of the second roller pair **23** adjacent to the first roller pair **21** including the specific metal roller **21**B.

Therefore, in the first embodiment, a distance P2 between central axes of the specific metal roller **21**B and the downstream elastic roller **23**A is longer than a distance P1 between central axes of the specific metal roller **21**B and the upstream elastic roller **21**A. It is noted that, in the first embodiment, a diameter of the upstream elastic roller **21**A is identical to a diameter of the downstream elastic roller **23**A.

3. Features of Image Forming Apparatus (Particularly, of Belt Cleaner)

The belt cleaner **20** of the first embodiment includes the first roller pair **21** including the first elastic roller **21**A and the first metal roller **21**B, and the second roller pair **23** including the second elastic roller **23**A and the second metal roller **23**B. The circumferential velocity of the second elastic roller **23**A is lower than the circumferential velocity of the first metal roller **21**B.

Thereby, even when the traveling velocity of the belt **15** is raised, it is possible to avoid a rise in the circumferential velocity of the second metal roller **23**B in contact with the scraping blade **25**. Accordingly, it is possible to prevent occurrence of a great stick-slip vibration of the scraping blade **25**. Thus, it is possible to avoid a drop in efficiency for removing (retrieving) the adhesive material.

In the first embodiment, the belt cleaner **20** includes even numbers of roller pairs **21** and **23**. Further, the scraping blade **25** is disposed downstream in the traveling direction of the belt **15** (more specifically, the cleaner-facing surface **15**B) relative to the position where the cleaning roller **21**A contacts (the cleaner-facing surface **15**B of) the belt **15**.

Thereby, in the first embodiment, it is possible to prevent an increase in a vertical dimension of the belt cleaner **20** including the plurality of roller pairs **21** and **23** and the scraping blade **25**, and to easily let the adhesive material scraped off by the scraping blade **25** fall downward.

If the scraping blade **25** were located upstream in the traveling direction of (the cleaner-facing surface **15**B of) the belt **15**, the scraping blade **25** would need to be disposed above the second metal roller **23**B. Therefore, since the scraped material might accumulate on the second metal roller **23**B, it might be difficult to let the adhesive material fall downward.

In the first embodiment, the contact surface pressure at the second contact portion S2 is lower than the contact surface pressure at the first contact portion S1. Thereby, in the first embodiment, it is possible to prevent generation of a great rotational resistance at the second contact portion S2 where the first metal roller **21**B and the second elastic roller **23**A contact each other while rotating in the mutually-opposite rotational tangential directions.

Second Embodiment

In the first embodiment, the diameter of the first metal roller **21**B is equal to the diameter of the second metal roller **23**B. In a second embodiment, a diameter of the second metal roller **23**B, which contacts the scraping blade **25**, is larger than a diameter of the first metal roller **21**B that does not contact the scraping blade **25**.

In the meantime, as a surface with which the scraping blade **25** is in contact becomes flatter (i.e., as a curvature of the surface that contacts the scraping blade **25** becomes smaller), the scraping blade **25** is able to more efficiently scrape the adhesive material. In the second embodiment, the second metal roller **23**B with which the scraping blade **25** is in contact has a diameter larger than the diameter of the first metal roller **21**B. Therefore, it is possible to achieve a small curvature of the outer circumferential surface of the second metal roller **23**B that contacts the scraping blade **25**. Thus, it is possible to more efficiently scrape the adhesive material.

Further, as the diameter of the second metal roller **23**B that contacts the scraping blade **25** becomes larger, a time period for which the scraping blade **25** slides relative to and in contact with an identical portion of the second metal roller **23**B becomes shorter. Accordingly, it is possible to prevent

the second metal roller **23**B from being damaged easily or quickly, and to improve durability of the second metal roller **23**B.

Hereinabove, the embodiments according to aspects of the present invention have been described. The present invention can be practiced by employing conventional materials, methodology and equipment. Accordingly, the details of such materials, equipment and methodology are not set forth herein in detail. In the previous descriptions, numerous specific details are set forth, such as specific materials, structures, chemicals, processes, etc., in order to provide a thorough understanding of the present invention. However, it should be recognized that the present invention can be practiced without reapportioning to the details specifically set forth. In other instances, well known processing structures have not been described in detail, in order not to unnecessarily obscure the present invention.

Only exemplary embodiments of the present invention and but a few examples of their versatility are shown and described in the present disclosure. It is to be understood that the present invention is capable of use in various other combinations and environments and is capable of changes or modifications within the scope of the inventive concept as expressed herein. For example, the following modifications are possible. It is noted that, in the following modifications, explanations of the same configurations as exemplified in the aforementioned embodiments will be omitted.

Modifications

In the aforementioned embodiments, the first elastic roller **21**A, the first metal roller **21**B, the second elastic roller **23**A, and the second metal roller **23**B are configured to rotate in a mechanically synchronized manner, via power transmission members (not shown) such as gears and toothed belt. Nonetheless, the present invention is not limited to such a configuration.

In the aforementioned first embodiment, the ratio of the circumferential velocity of the first elastic roller **21**A to the traveling velocity of the cleaner-facing surface **15**B is about 0.6. The ratio of the circumferential velocity of the first metal roller **21**B to the traveling velocity of the cleaner-facing surface **15**B is about 0.6. The ratio of the circumferential velocity of the second elastic roller **23**A to the traveling velocity of the cleaner-facing surface **15**B is about 0.36. The ratio of the circumferential velocity of the second metal roller **23**B to the traveling velocity of the cleaner-facing surface **15**B is about 0.36. Nonetheless, the present invention is not limited to such a configuration.

In the aforementioned embodiments, exemplified is the configuration that the two roller pairs **21** and **23** are provided. However, according to aspects of the present invention, three or more roller pairs may be provided.

In the aforementioned embodiments, the scraping blade **25** is disposed downstream in the traveling direction of the cleaner-facing surface **15**B of the belt **15** relative to the contact position where the cleaning roller **21**A contacts the cleaner-facing surface **15**B. However, for instance, the scraping blade **25** may be disposed upstream in the traveling direction of the cleaner-facing surface **15**B of the belt **15** relative to the contact position where the cleaning roller **21**A contacts the cleaner-facing surface **15**B.

In the aforementioned embodiments, the arrangement direction of the rollers **21**A, **21**B, **23**A, and **23**B is a direction oriented toward a downstream side in the traveling direction of the cleaner-facing surface **15**B from the contact position where the cleaning roller **21**A contacts the cleaner-facing surface **15**B. Further, the arrangement direction of the rollers **21**A, **21**B, **23**A, and **23**B intersects the cleaner-facing surface **15**B of the belt **15**. Nonetheless, the present invention is not limited to such a configuration.

In the aforementioned first embodiment, the contact surface pressure at the second contact portion S2 is set lower than the contact surface pressure at the first contact portion S1. However, the contact surface pressure at the second contact portion S2 may be set the same as the contact surface pressure at the first contact portion S1.

What is claimed is:

1. An image forming apparatus comprising:

an endless belt wound around at least two rollers;

an electrophotographic image forming unit disposed to face the endless belt; and

a belt cleaner configured to remove adhesive material adhering onto the endless belt, the belt cleaner comprising:

a scraping blade; and

a plurality of roller pairs each comprising:

an elastic roller having an outer circumferential surface made of elastic material; and

a metal roller having an outer circumferential surface made of metal, the metal roller disposed to contact the outer circumferential surface of the elastic roller, the metal roller configured to remove adhesive material adhering onto the outer circumferential surface of the elastic roller while rotating in a rotational tangential direction identical to a rotational tangential direction of the elastic roller at a contact portion between the metal roller and the elastic roller,

wherein the plurality of roller pairs comprise:

a first roller pair comprising a first elastic roller that is a cleaning roller disposed to contact the endless belt and configured to remove the adhesive material adhering onto the endless belt while rotating in a rotational tangential direction opposite to a traveling direction of the endless belt at a contact portion between the cleaning roller and the endless belt; and

one or more second roller pairs different from the first roller pair, each second roller pair comprising a second elastic roller disposed to contact an adjacent metal roller included in a roller pair adjacent to the second roller pair, the second elastic roller configured to remove adhesive material adhering onto an outer circumferential surface of the adjacent metal roller while rotating at a circumferential velocity lower than a circumferential velocity of the adjacent metal roller in a rotational tangential direction opposite to a rotational tangential direction of the adjacent metal roller at a contact portion between the second elastic roller and the adjacent metal roller, and

wherein the scraping blade is disposed to contact an outer circumferential surface of a specific metal roller included in a specific roller pair of the one or more second roller pairs different from the first roller pair, and configured to scrape adhesive material adhering onto the outer circumferential surface of the specific metal roller.

2. The image forming apparatus according to claim **1**,

wherein the plurality of roller pairs of the belt cleaner are an even number of roller pairs, and

wherein the scraping blade is disposed downstream in a traveling direction of the endless belt relative to the contact portion between the cleaning roller and the endless belt.

3. The image forming apparatus according to claim 1,
wherein the elastic rollers and the metal rollers of the plurality of roller pairs are arranged along a predetermined direction oriented from the contact portion between the cleaning roller and the endless belt toward a downstream side in the traveling direction of the endless belt, the predetermined direction intersecting a cleaner-facing surface of the endless belt that faces the belt cleaner.

4. The image forming apparatus according to claim 1,
wherein the metal rollers of the plurality of roller pairs comprise a double-contact metal roller configured to contact two elastic rollers comprising:
a first-adjacent elastic roller included in a roller pair including the double-contact metal roller; and
a second-adjacent elastic roller included in a roller pair adjacent to the roller pair including the double-contact metal roller, and
wherein a contact surface pressure between the double-contact metal roller and the second-adjacent elastic roller is lower than a contact surface pressure between the double-contact metal roller and the first-adjacent elastic roller.

5. The image forming apparatus according to claim 4,
wherein the first-adjacent elastic roller has a diameter identical to a diameter of the second-adjacent elastic roller, and
wherein a distance between central axes of the double-contact metal roller and the second-adjacent elastic roller is longer than a distance between central axes of the double-contact metal roller and the first-adjacent elastic roller.

6. The image forming apparatus according to claim 1,
wherein the specific metal roller disposed to contact the scraping blade has a diameter larger than a diameter of any other metal roller included in the plurality of roller pairs.

7. The image forming apparatus according to claim 1,
wherein the plurality of roller pairs are two roller pairs.

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